



Virtual People: Thesis Topics '03
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Virtual People

- Virtual People (VP's) are software agents that simulate humans in virtual environments
- Virtual environments are key for immersive simulations for training and analysis
- Virtual people play the role of
 - Enemies
 - Team members
 - Instructors

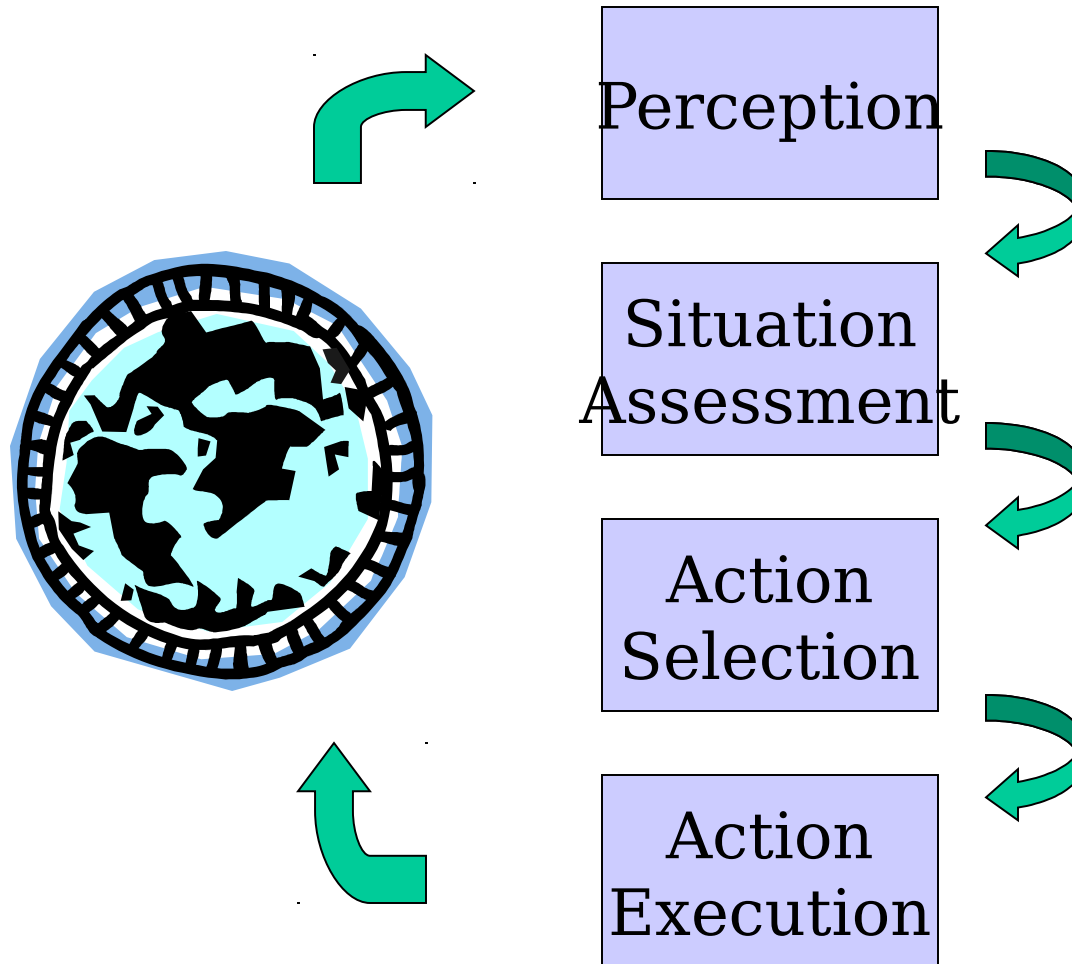
Virtual People: Importance

- Virtual people are a critical technology for training and analysis because
 - Training/analysis is valid only when the virtual people behave sufficiently realistically.
Unrealistic training/analysis is dangerous!!
 - Economic necessity, i.e. there are too many roles to play and people cost too much to use them for all roles
 - Some applications (e.g. terrorist scenarios) of current importance depend particularly heavily on accurate simulation of individuals

Traditional AI Stovepipes

- Sub-disciplines
 - Computer vision
 - Natural language
 - Machine learning
 - Statistical methods (Uncertainty)
- Research stovepiping leads to:
 - Suboptimal coordination when algorithms and codes from one discipline are integrated with others
 - Lack of clarity as to the impact of problems on the performance of larger systems (agents/VP's)

Generic Agent Architecture

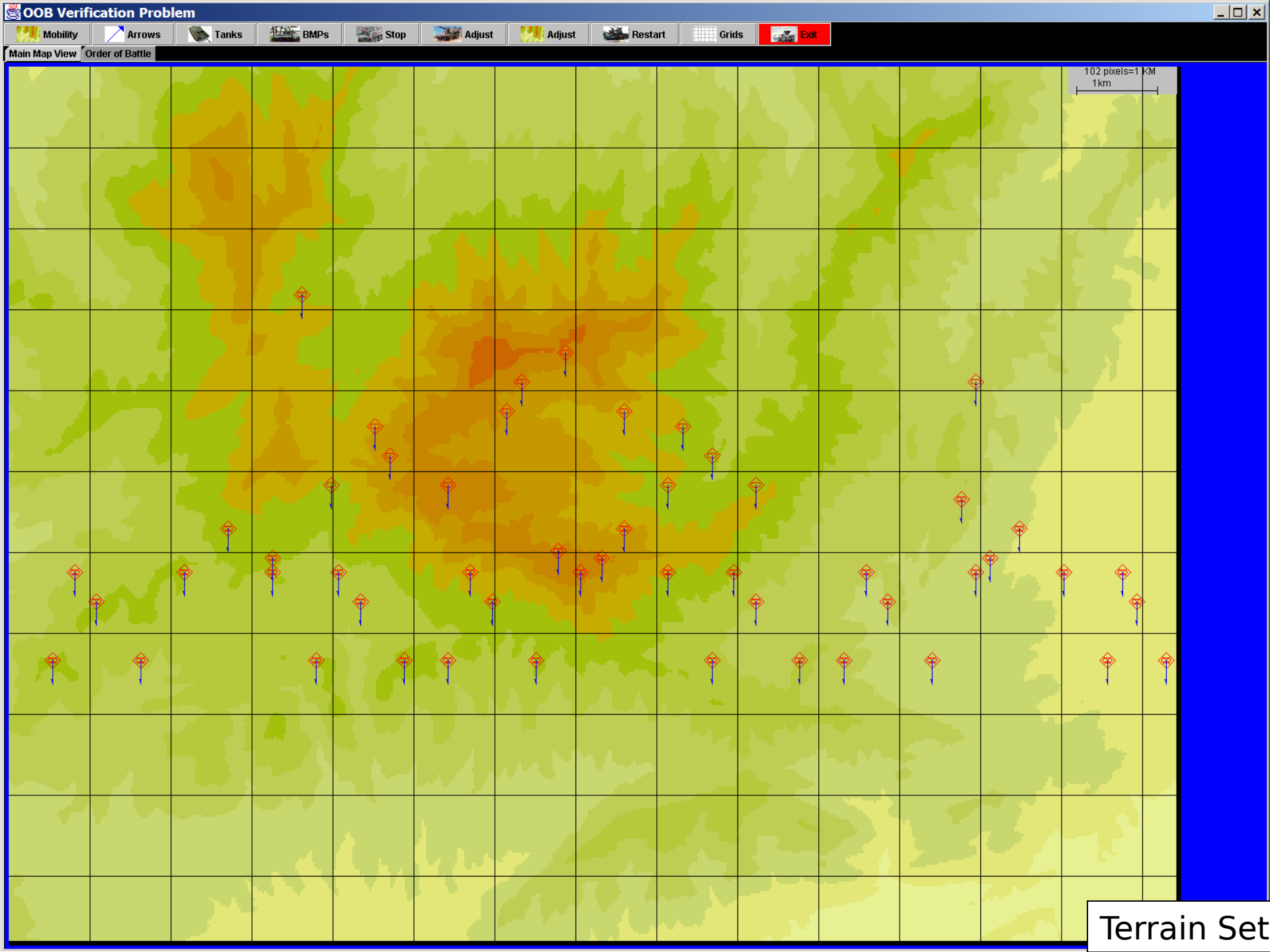


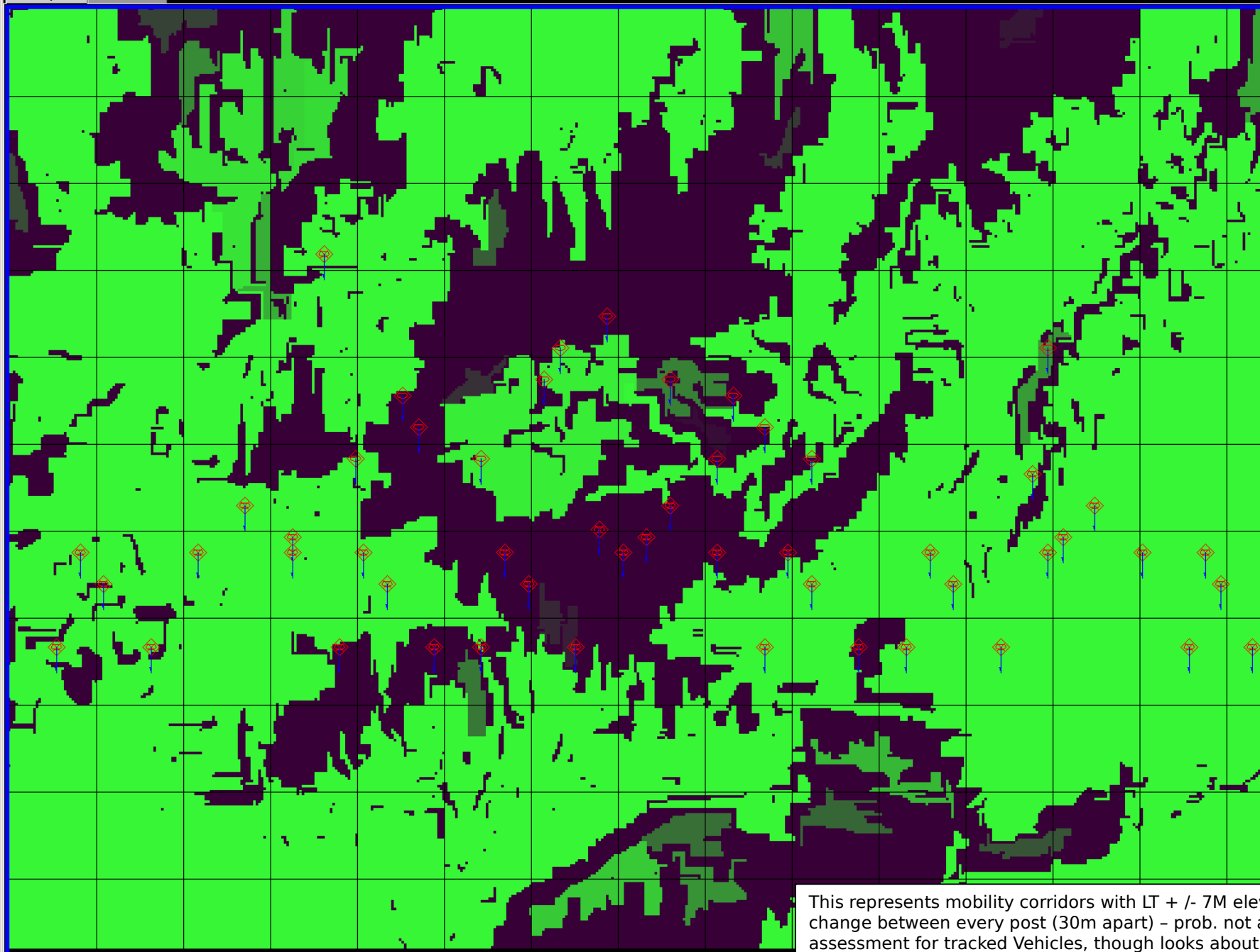
Virtual People

- Deal with tasks that are
 - Complete
 - Interesting
 - Similar to those undertaken by real people
- Often
 - Deal with sensory and/or motor processing
 - Emulate human cognition
 - Spatial cognition
 - Dynamics (expectation generation)

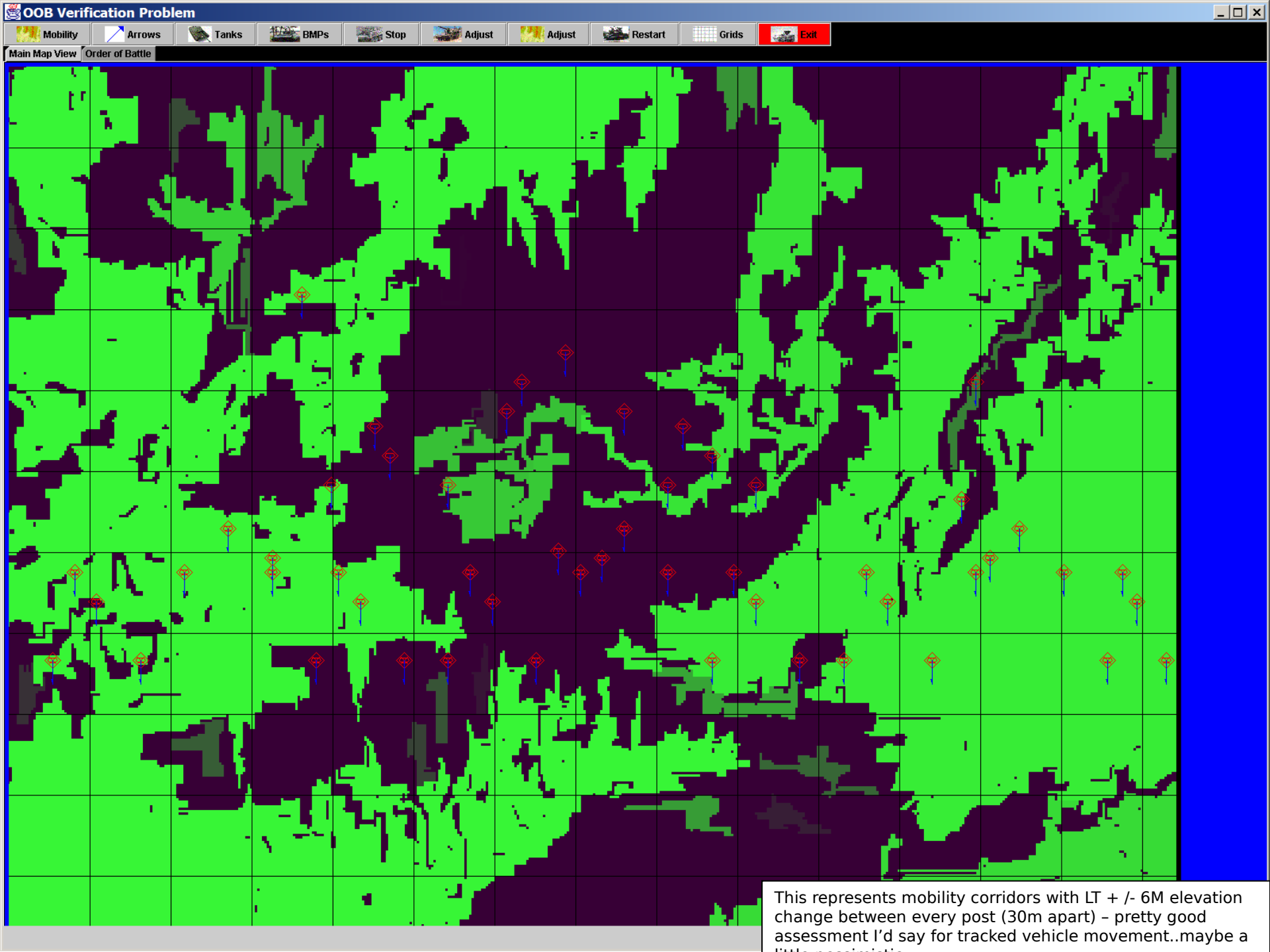
Intelligence Agent

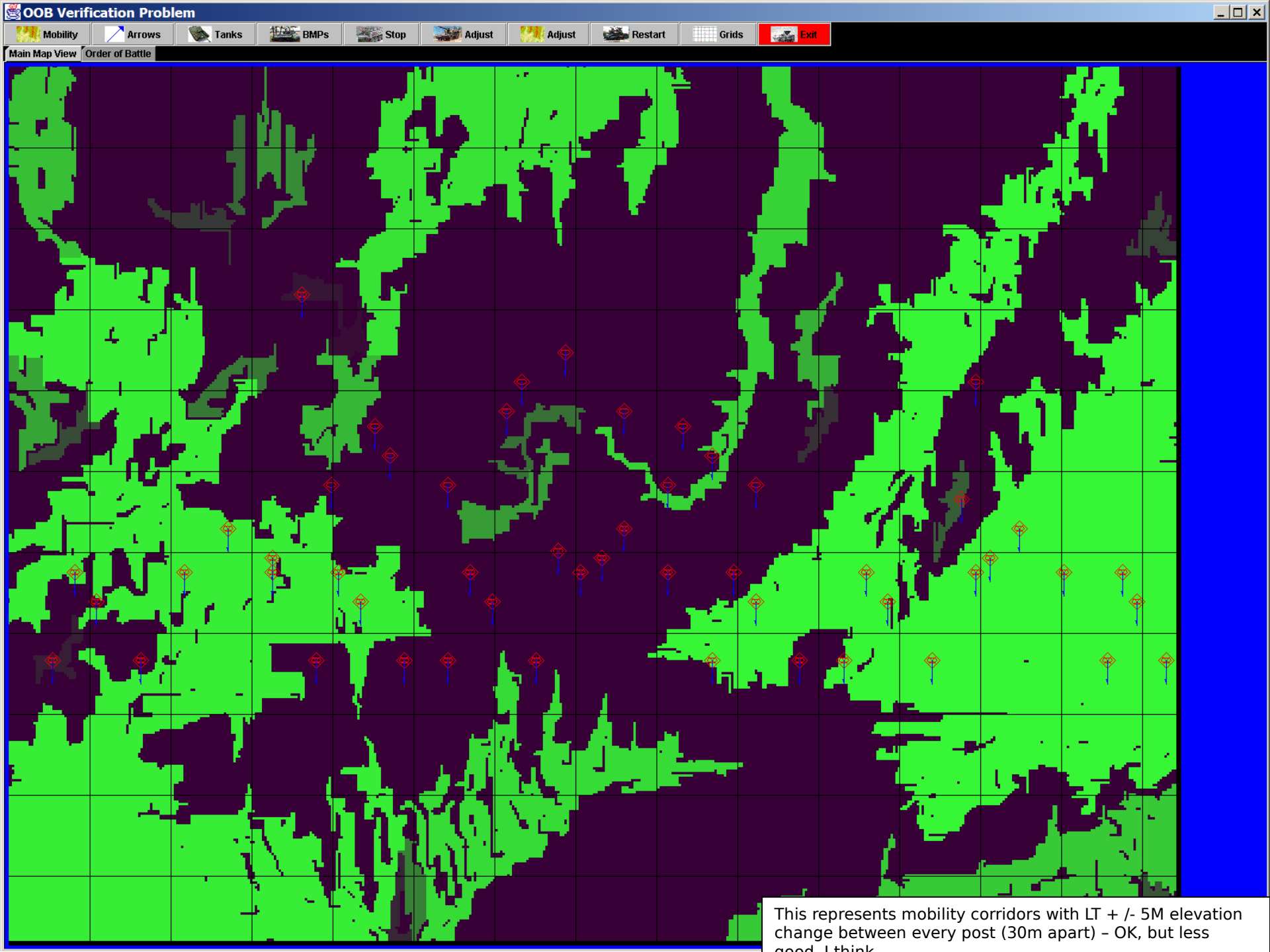
- *Build a VP (or a VP component) that emulates a battalion intelligence officer for use with training sims like JSAF, JCATS, and their replacements*
- Components
 - Unit identification (who are we up against?)
 - Strength assessment (friendly and enemy)
 - Deployment identification (where are they?)
 - Plan assessment (are we on track?)
 - Report generation (text, talking head)
 - Natural language processing (text chat)

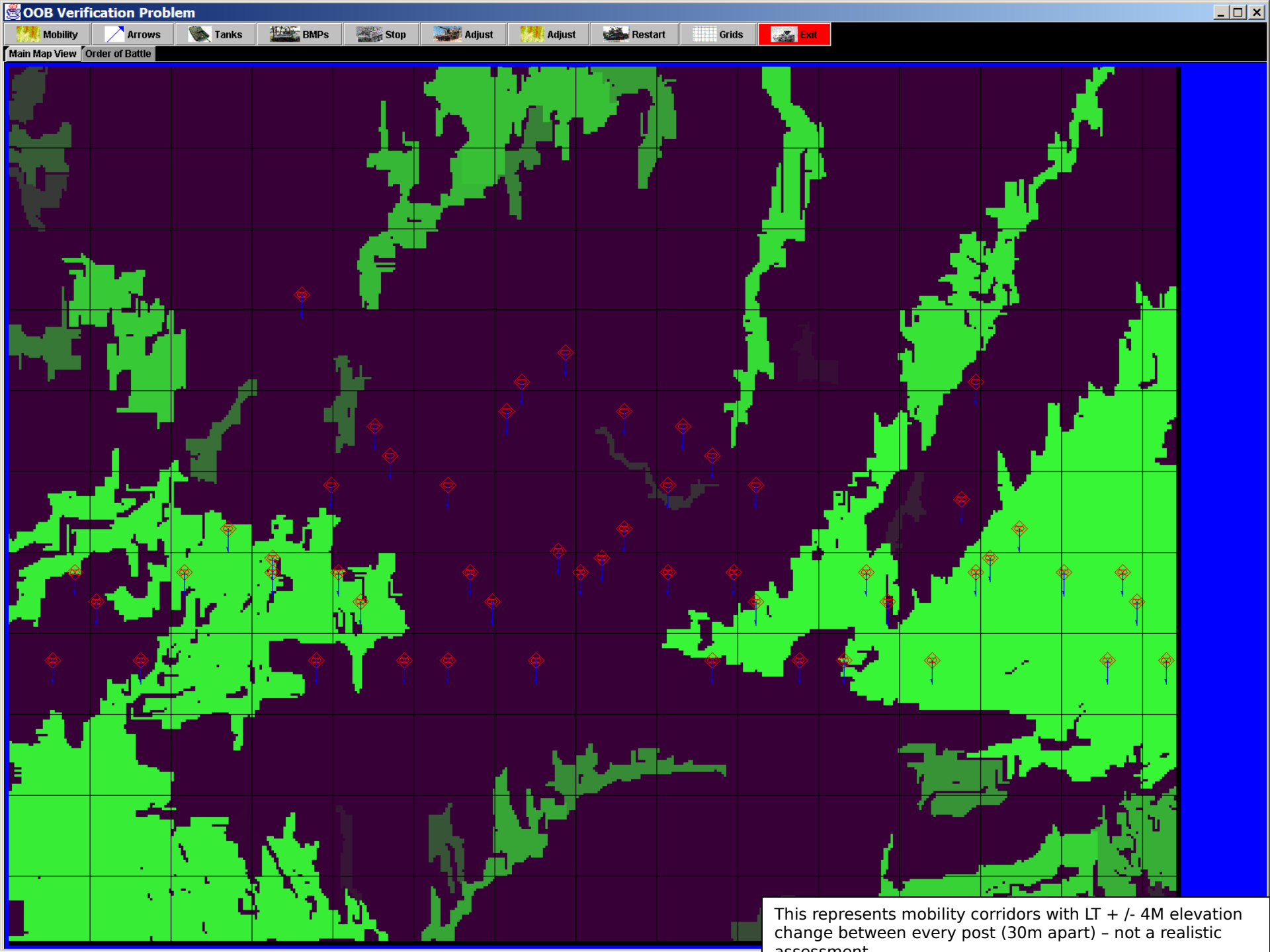




This represents mobility corridors with $LT \pm 7M$ elevation change between every post (30m apart) - prob. not a realistic assessment for tracked Vehicles, though looks about right for a wheeled transport.

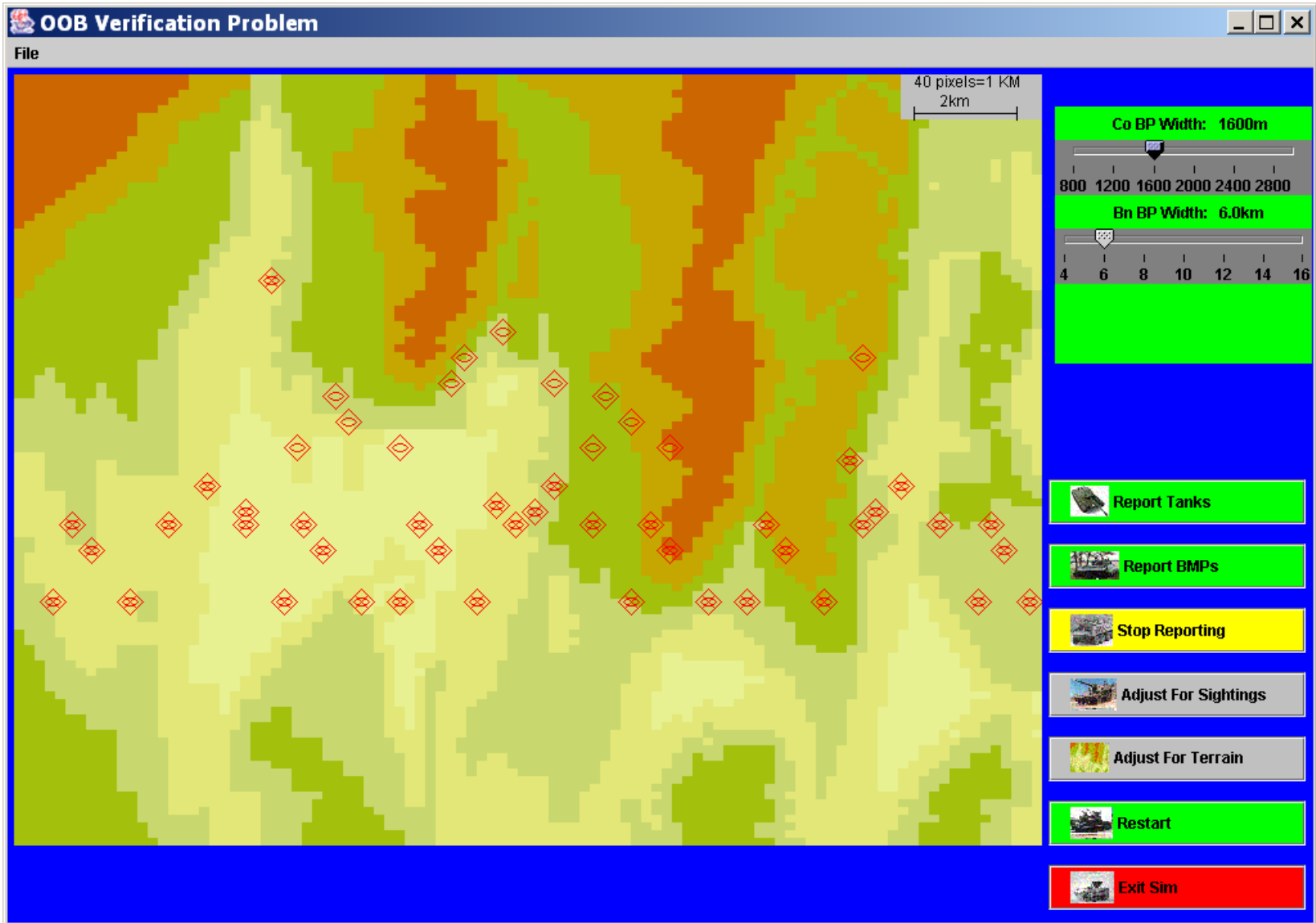




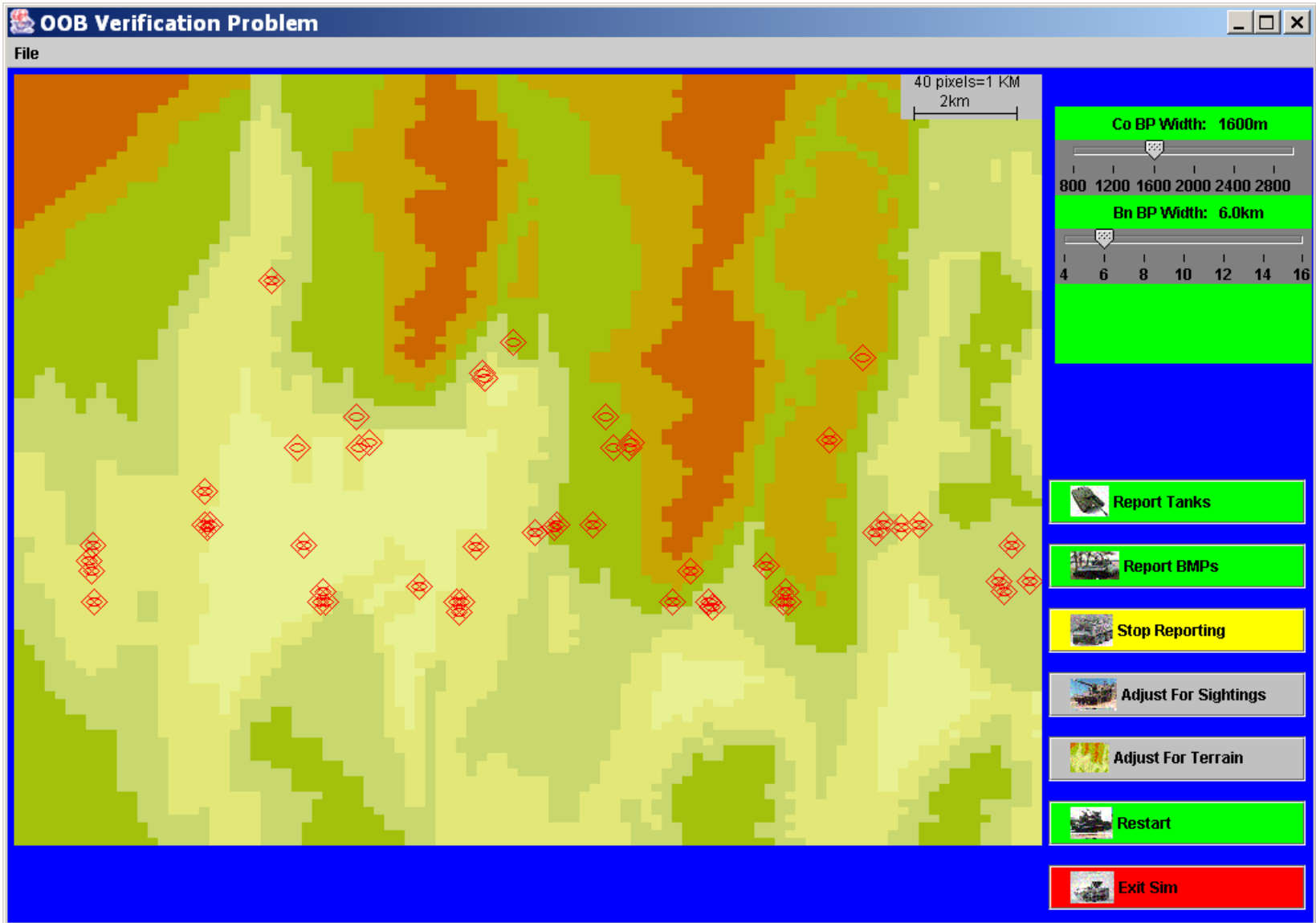


This represents mobility corridors with $LT \pm 4M$ elevation change between every post (30m apart) - not a realistic assessment

Before Terrain Analysis

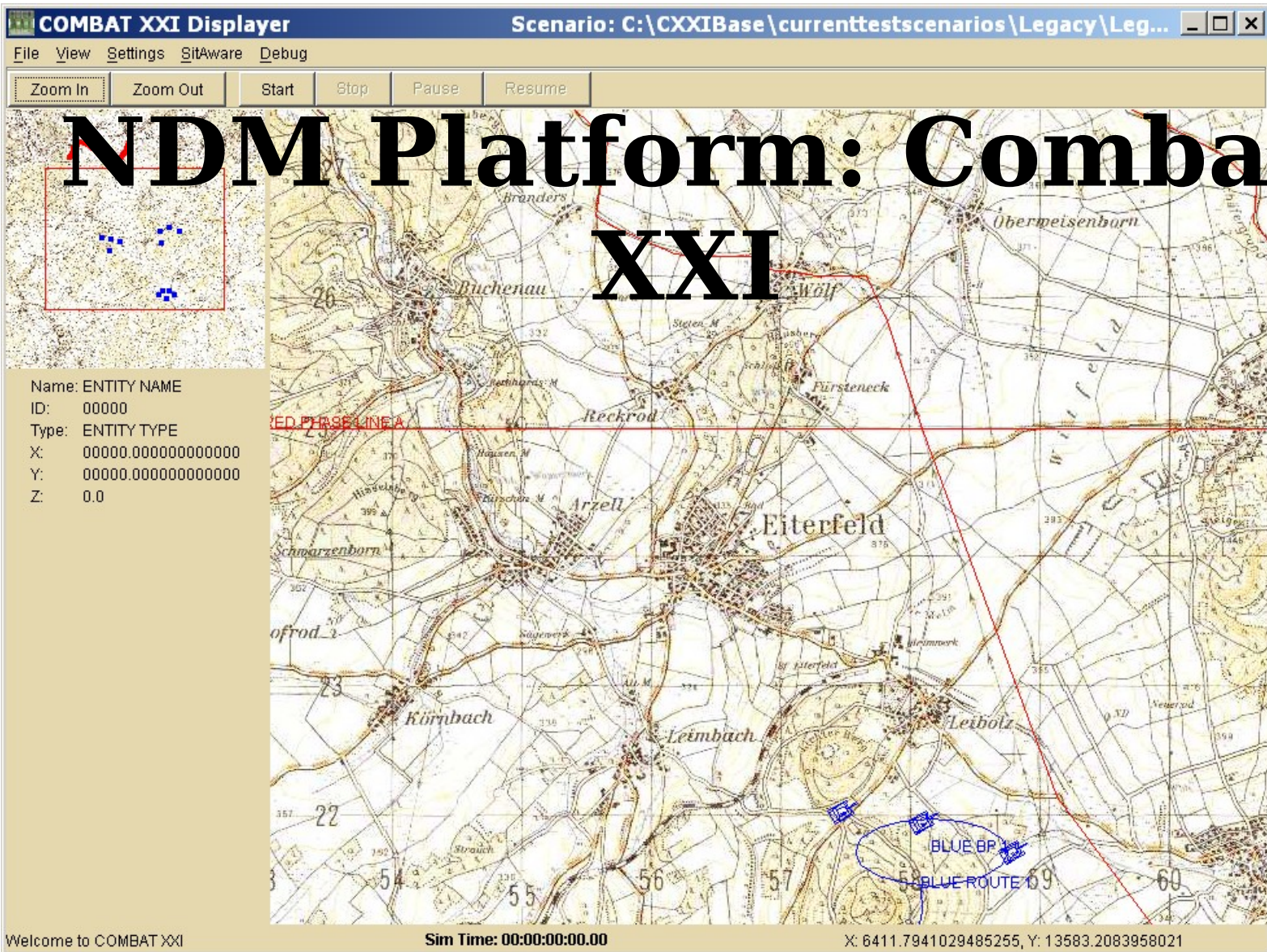


After Terrain Analysis



NDM for Information Fusion

- Natural decision making to exploit and analyze a Common Operational Picture (COP)
- Joint project with TRAC Monterey and OR
- *Build a VP that integrates the information in a COP prototype into a coherent situation representation (e.g. a prioritized list of threats for fire allocation)*



Realistic Fire Teams for *America's Army*



- *Build a realistic fire team member that is terrain-aware and moves and responds to events consistent with accepted doctrine*
- *In Progress:*
 - *Location of covered positions*
 - *Intelligent static defense (watch and fire)*
- *Need:*
 - *Concealed routes*
 - *Coordinated suppression and movement*

Summary: Thesis Opportunities

- Concealed routes
- Key terrain identification
- Outcome extrapolation
- NDM and COP
- Realistic fire-team behavior
- Natural language situation report generation
- Speech recognition and generation

What You Need to Build VP's

- Some AI/agent knowledge (but taking every possible course is certainly not necessary)
- Programming ability (C++ or Java are both widely used, other systems use relatively simple scripting languages or even visual programming)
- Knowledge of (or willingness to learn) the military application domain
- Good starting points and existing components exist for most projects of interest

Maneuver Agent

- *Build a VP commander that accepts one of a small set of standard orders and deploys a company or battalion accordingly, taking appropriate action in response to unexpected events*

FORCEnet Agents (or other naval applications!)

- *Design and prototype an agent for context-sensitive communication with a sensor grid (inspired by mobile agents and/or natural language)*
- *Build a natural language module for parsing (a subset of) warning and/or operations orders into XML*
- *Build an agent that can work from an XML order and collect and display relevant information*

Portable Virtual People

- Today, virtual people are largely rewritten from scratch for each application
- This is counter-intuitive, since a VP could possibly be as complicated as the rest of the VE
- One might imagine instead trying to build a VP to be as maximally reusable as possible
- A specification of the requisite infrastructure should then be provided to VE builders

Portable VP's

- *Build a VP that can perform a task on two different platforms (e.g. navigate on a military simulator and a computer game)*
- *Build a VP that takes “screen scrapes” as input and produces simulated button presses and mouse clicks as outputs. Demo the agent on two different “shooter” games.*

Physical VP Models

- Tool support exists for building VP models for canned animation
- Very little exists for VP's that will be actively controlled at run-time using simulated physics
- Progress in controlled VP's requires the production of a readily-available (PD=public domain) model including joint lengths, angle constraints, etc.
- The model can then be controlled using a simplified simulated physics

Physically-Based Animation

- *Build a VP that learns to control its motion by trial and error. Apply to benchmark task(s) such as operating a console, walking, or using a tool in a confined space.*

VP's vs. Generic Agents: Situation Awareness

- Tracking many aspects of the environment
- Multiple hypotheses
- Qualitative models
- Spatial distribution representations
- Spatial action representation
- Context-sensitive communication
- Potential use of natural language
- Execution monitoring

Realism and VP's

- The current generation of VP's is realistic when...
 - Dead
 - Sleeping
 - They have a good excuse to ignore most of the world (e.g. they are obsessed, too important, etc.)
 - You are under fire and can not pay attention to them
- Summary: good enough to make entertaining computer games, but not good enough for military applications

Virtual People

- We want to make Virtual People (simulated humans for VE's) that are
 - Smarter
 - More human
 - Able to communicate
- A realistic near-term goal is to develop a VP architecture that
 - Provides human-like functionality for the agent developer
 - Promotes reuse of significant components
 - Supports broad awareness of context
 - Supports the use of language

Integrated Nonverbal Communication

- Nonverbal communication is a large area including
 - Touching
 - Pointing
 - Gestures (e.g. hand signals)
 - Gesticulation
 - Facial expression
- These topics are generally easier to handle than language-based communication, and might add a disproportionately high degree of realism to VP's

Possible Technology Areas

- Architecture
 - Infrastructure/capability analysis
 - Generic (portable) virtual people
 - Simulated teams
- Motion control (animation)
 - Physical and quasi-physical models
- Communication
 - Integrated nonverbal communication
 - Integrated synthetic speech
 - Integrated speech recognition

Infrastructure/Capability Analysis

- What infrastructure is necessary to support what sort of desirable VP capabilities?
- Infrastructure consists mostly of the set of percepts available to a VP
- One end of the spectrum is the infrastructure of current gaming engines. What are the most advanced capabilities that this infrastructure could support?
- The opposite end of the spectrum is, of course, passing the VP a full video and audio feed. What capabilities could be built on this rich infrastructure with today's technology?

How Do We Get There?

- By building lots of VP's!
- Each VP should introduce some new technological elements and apply to some military domain

Military VE's

- VE's (Virtual Environments) have three primary military applications
 - Educating personnel, including instruction, training, drill, mission rehearsal, etc.
 - System assessment and development, including the assessment of hardware, software, strategies, tactics, and hypothesis generation and testing
 - Information display (not relevant to this presentation)

Realism in VE's

- Necessary to promote immersion in the case of training applications
- Necessary to validate analytical applications

Simulated Teams

- It might actually be easier to build teams of multiple VP's, rather than individuals
- A complete simulated team allows automated improvement of the team via learning algorithms (e.g. genetic algorithms, neural networks, etc.)

Integrated Speech Recognition

- Speech recognition is currently quite good enough for “command and control” applications
- Knowledge of the task and the current context in a VE could aid in the production of a more general speech recognition facility

Integrated Synthetic Speech

- The current generation of synthetic speech is still easy to discriminate from human speech, but it is gradually getting better
- It is at least generally comprehensible
- The current technology is mature enough for experimental applications in VP teammates or trainers